**GRADUATE INSTITUTE OF AGRI-BUSINESS MANAGEMENT**

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**Research Proposal Letter for Ph.D. (ABM)**

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| **8. Title of Research Project** | : | **MINIMISATION OF PRE- AND POST-HARVEST LOSSES OF SELECTED FRUIT CROPS IN THE SAURASHTRA REGION OF GUJARAT** |

## 9. Introduction

India's agricultural sector has experienced significant structural changes over the last few decades, especially following the economic liberalization reforms of the 1990s. One of the most notable developments has been the rise of integrated systems linking agriculture, food supply and value chains. There is a growing emphasis on activities such as processing, marketing and export across all stages of the agricultural chain. As a result, conventional farming practices are gradually giving way to more organized, industry-like approaches that involve stronger coordination among farmers, processors, retailers, exporters and other participants within the agricultural value chain. This transformation reflects a shift toward a more interconnected and market-oriented agricultural system (Kumar *et al.,* 2011).

Horticulture has emerged sector of India's agricultural transformation by promoting the cultivation of high-value crops that enhance farm profitability and sustainability. The horticulture sector contributes not only to higher farmer incomes but also to improved nutrition, employment generation and efficient land use. Over the years, production has increased

substantially, supported by improved productivity and expansion of cultivated areas. This growth aligns with national strategies aimed at doubling farmers' income through the adoption of high-value agricultural practices.

Horticulture plays a vital role in agricultural diversification by including a wide range of crops such as fruits, vegetables, flowers, spices and medicinal plants, and it has emerged as an important driver of economic development and nutritional security in India. The Saurashtra region of Gujarat, with its diverse soils, climatic conditions and long coastal belt, possesses rich horticultural biodiversity. Major fruit crops like mango, with popular indigenous varieties such as Kesar and Rajapuri, along with custard apple, guava and jamun, contribute significantly to the region's agricultural economy. Additionally, hardy crops like karonda and lasora are suitable for wastelands and climate resilience. The region also supports coconut plantations and a variety of flower and vegetable crops, reflecting its wide genetic diversity. However, there is a strong need for systematic conservation, documentation and utilisation of these genetic resources to enhance productivity and sustainability. Strengthening horticultural development in this region can significantly contribute to income generation, food security and climate adaptation (Varu *et al.,* 2017).

Reducing post-harvest losses is essential for increasing the effective availability of fruits and vegetables without raising production levels. It offers both ethical and economic benefits, as loss prevention typically requires less investment than producing additional output. Assessing losses at different handling stages helps identify their extent and underlying causes, enabling better management strategies. A detailed evaluation, including economic valuation and supply chain analysis, is necessary to locate critical loss points. Improving transport, storage, packaging and processing enhances efficiency and reduces wastage. Incorporating these losses into marketing cost analysis also ensures accuracy, supporting informed policy decisions to strengthen supply chains and reduce overall losses (APEDA, 2025).

Pre-harvest management practices are crucial for enhancing the quality and storage life of fruits like mango, particularly in developing regions where such interventions are not widely adopted. Research has demonstrated that the application of plant growth regulators prior to harvest can significantly improve post-harvest performance. For instance, treatments with gibberellic acid ($GA_3$) and salicylic acid (SA) have been found to extend shelf life, reduce physiological weight loss, delay ripening and lower disease incidence. In addition, these treatments contribute to better nutritional quality by increasing levels of ascorbic acid and β-carotene in fruits. Overall, pre-harvest interventions can play a vital role in maintaining fruit quality and reducing post-harvest losses (Iqbal, 2020).

Pre-harvest management important role in minimising post-harvest losses and enhancing the quality of mango fruits. Integrated strategies—such as balanced nutrient management, proper pruning, reduction of field-level disease inoculum and the judicious application of fungicides—have been shown to effectively control major diseases like stem-end rot and anthracnose. In addition, the use of healthy planting material, improved nursery practices and the selection of disease-resistant varieties are important long-term measures for sustainable production. Evidence from field-level implementations indicates that these practices significantly lower disease incidence while improving fruit shelf life and market acceptability. Thus, strengthening pre-harvest management is essential for improving overall efficiency in the mango value chain (Kazmi *et al.,* 2014).

India's food processing sector is among the fastest-growing and most diversified industries, playing a crucial role in production, consumption, employment generation and exports. It covers multiple segments such as fruits and vegetables, dairy, meat and poultry, fisheries, cereals, spices, plantation crops and value-added products including beverages, confectionery, soy-based items and fortified foods. Following the economic liberalization of 1991, the industry experienced notable expansion driven by supportive government policies promoting private participation, foreign collaborations, joint ventures and export-oriented units. In recent years, it has become an attractive destination for foreign direct investment, with cumulative inflows reaching about USD 13 billion between April 2000 and December 2024. The sector now contributes nearly one-third of India's total food market and holds a strong position in output and export growth. In 2024–25, processed food exports surpassed USD 7.8 billion, supported by diverse products and India's advantageous global trade connectivity. Government initiatives, particularly the Make in India program, have strengthened the sector by promoting investment, innovation, skill development and infrastructure creation. Government initiatives, particularly the Make in India program, have strengthened the sector by promoting investment, innovation, skill development and infrastructure creation. Overall, the food processing industry significate role in enhancing value addition, reducing post-harvest losses, generating employment and supporting the country's economic growth. Overall, the food processing industry plays a vital role in enhancing value addition, reducing post-harvest losses, generating employment and supporting the country's economic growth (Department of Agriculture and Farmers Welfare, 2025).

India is known worldwide for its extensive diversity of mango varieties, which differ in size, shape, colour, taste and aroma. Beyond its popularity as a delicious fruit, mango is nutritionally valuable, providing dietary fibre, potassium, beta-carotene and antioxidants. It is

primarily cultivated in tropical and subtropical regions under warm conditions, up to elevations of about 1,500 meters. To meet international quality standards, advanced pack houses and post-harvest technologies such as hot water treatment, vapour heat treatment and irradiation are widely used. Traceability systems and residue monitoring further ensure food safety and compliance. Although India is the origin of numerous varieties, only a few are commercially cultivated, with regional variations in maturity periods. Major producing states include Uttar Pradeshandhra Pradesh, Karnataka, Gujarat, Bihar, Tamil Nadu and Madhya Pradesh. India also exports fresh mangoes and processed products like pulp, which is widely used in beverages and desserts (Department of Agriculture and Farmers Welfare, 2025).

**9.1 About: Gujarat**

Gujarat, situated on India's western coast, is among the country's most economically advanced and progressive states. It wewestablished on 1 May 1960 following the division of the former Bombay State during the Mahagujarat Movement. The state has a long historical background connected with trade, culture and agriculture, with evidence from the Indus Valley Civilization at sites such as Lothal indicating early commercial and farming activities. Agriculture remains a key component of the rural economy, supported by diverse agro-climatic zones that enable cultivation of crops like cotton, groundnut, wheat and rice, along with horticultural crops such as mango, banana and cumin. Institutional support and irrigation development have strengthened productivity. Gujarat also has a strong industrial base in sectors like textiles and petrochemicals. With efficient infrastructure, major ports and business-friendly policies, the state plays a big role in India's economic development and export growth (Shukla, 2010).

**9.2 Fruits Scenario: Gujarat**

The distribution of fruit cultivation in Gujarat during 2024–25 reflects significant regional variation in area, production and productivity across different agro-climatic zones. In South Gujarat, fruit cultivation covered about 1.57 lakh hectares, producing over 30.8 lakh metric tonnes with an average productivity of 19.65 MT per hectare. Among the districts, Bharuch and Narmada recorded notably high productivity levels, indicating efficient cultivation practices, while Dang exhibited comparatively lower yields. Middle Gujarat accounted for approximately 81,300 hectares under fruit crops, with a total output exceeding 27.4 lakh metric tonnes and an average productivity of 33.70 MT per hectare. Districts such as Anand and Chhota Udepur demonstrated exceptionally high productivity, suggesting better irrigation facilities, improved varieties and advanced management practices in these regions. Districts such as Anand and Chhota Udepur demonstrated exceptionally high productivity,

suggesting better irrigation facilities, improved varieties and advanced management practices in these regions. In North Gujarat, fruit cultivation extended across nearly 1.11 lakh hectares, generating about 17.3 lakh metric tonnes with a productivity of 15.63 MT per hectare. Kutch had the largest area under fruit cultivation in this zone, though productivity remained moderate compared to districts like Aravalli, which showed relatively higher yield efficiency (Directorate of Horticulture, Government of Gujarat, 2025).

**9.3 Fruits Scenario: Saurashtra**

The Saurashtra–Kutch region, which includes districts such as Junagadh, Bhavnagar and Amreli, covered around 95,165 hectares with a production of over 10.26 lakh metric tonnes. The Saurashtra–Kutch region, which includes districts such as Junagadh, Bhavnagar and Amreli, covered around 95,165 hectares with a production of over 10.26 lakh metric tonnes. However, this zone recorded the lowest average productivity of 10.78 MT per hectare among all regions, reflecting constraints such as limited irrigation and variable climatic conditions. Overall, Gujarat reported a total fruit cultivation area of approximately 4.44 lakh hectares, producing around 85.8 lakh metric tonnes with an average productivity of 19.32 MT per hectare. These variations across zones highlight the influence of regional resources, infrastructure and technological adoption on horticultural performance in the state. These variations across zones highlight the influence of regional resources, infrastructure and technological adoption on horticultural performance in the state (Directorate of Horticulture, Government of Gujarat 2025).

**9.4 Nutrition Value of Fruit Crops**

Fruits occupy a vital place in daily food intake due to their rich nutritional composition. They contribute significantly to essential vitamins and minerals and have been consumed by humans since ancient times. Regular consumption of fruits contributes significantly to maintaining good health and enhancing body vitality. Nutrition experts generally recommend a daily intake of around 115 grams of fruits as part of a balanced diet. Common fruits such as papaya, mango, guava, jackfruit, pineapple and lemon are rich in vitamins A, B and C, along with important minerals like calcium, magnesium, iron and potassium. Additionally, fruits like wood apple, litchi, almond and karamcha provide phosphorus and amino acids in appreciable quantities. In countries like India, cereals such as rice and wheat form the staple diet, whereas in some regions of the world, particularly in South America, fruits like banana are consumed as a primary food source. Fruits such as banana, jackfruit, guava and pineapple can play a significant role in addressing food shortages. Their nutritional richness, especially in vitamins

and minerals, makes them an essential component of daily diets. Moreover, regular fruit consumption improves digestion and supports overall well-being (Rahman, 1998).

Fruits are suitable for consumption at any time of the day and are considered ideal snacks due to their convenience and nutritional benefits. They are generally low in calories and fat (except for fruits like avocado and olives), free from cholesterol and rich in carbohydrates and dietary fiber. Fruits are also good sources of vitamin C, carotene and in some cases vitamin B6. Along with vegetables, fruits are low in sodium and high in potassium, which supports cardiovascular health. The presence of ascorbic acid enhances the absorption of iron in the body. Due to these properties, fruits and vegetables play a crucial role in maintaining a healthy diet.

Numerous studies have indicated that higher consumption of fruits and vegetables is associated with a reduced risk of major diseases and may help delay the onset of age-related health issues. Despite these benefits, the intake of fruits and vegetables often remains below the recommended levels of 5–10 servings per day. The nutritional composition of fruits varies widely depending on factors such as species, variety and stage of maturity. Since no single fruit contains all essential nutrients in sufficient quantities, a diverse intake is necessary. In this context, the present study aims to comprehensively analyze post-harvest losses in major fruit crops.

**10. Practical Utility of the Research Projects**

This study addresses the pressing issue of post-harvest losses in fruit crops and their impact on farmers' income, food supply and agricultural sustainability. In the Saurashtra region of Gujarat, where fruit cultivation supports rural livelihoods, reducing such losses is vital. Losses arise due to poor handling, inadequate storage, inefficient transport and unfavourable market conditions, leading to both quantity and quality deterioration. Limited region-specific research highlights a gap in understanding farmers' loss-management practices and the role of market and policy factors. Therefore, this study evaluates loss magnitude, cultivation costs and key determinants by integrating economic, technical and institutional dimensions.

**11. Objectives:**

The specific objectives of the present investigation are:

1. To estimate the cost incurred in the cultivation of selected major fruit crops within the study region

2. To evaluate the magnitude of pre-harvest and post-harvest losses in the selected fruits crops

3. To identify and examine the factors influencing pre-harvest and post-harvest losses in the selected fruit crops

4. To analyse the major constraints associated with post-harvest losses

5. To propose appropriate strategies and interventions aimed at reducing pre-harvest and post-harvest losses in selected fruit crops

**12. Review of literature:**

The present review is to an attempt at bringing together some of the findings on morphological, physio-biochemical and transcriptome profiling as per the objectives.

**12.1. Cost of cultivation fruit**

Prakash (2012) conducted an economic study focusing on the export potential of grapes in northern Karnataka. The analysis of growth movement in area, production and productivity revealed varying patterns. The instability index for area under grape cultivation was estimated at 9.97 per cent. During the same period, grape production exhibited a positive and statistically growth rate of 3.11 per cent, although it was associated with a relatively high instability index of 20.34 per cent. In contrast, productivity showed a negative and significant growth rate of -3.65 per cent, indicating a declining trend despite increased production.

Singh *et al.* (2013) analyzed the growth trends in area, production and productivity of important fruit crops in Jharkhand. The findings indicated a positive growth rate for most selected fruits, including litchi, mango, guava and banana, whereas citrus exhibited a declining trend. Period-wise analysis showed that the fourth period (2005–2010) was particularly favorable for litchi, mango and guava, while banana and citrus recorded negative growth during the same phase. The study further reported positive productivity growth rates of approximately 2.56 per cent for litchi and mango, 1.50 per cent for guava and 5.21 per cent for banana, contributing to an overall increase in fruit production in the state. Additionally, variability in cultivated area was highest for litchi (71 per cent), mainly due to shifts from other fruit crops, followed by mango and banana. In terms of productivity, banana exhibited the highest variability, whereas other fruit crops showed relatively stable yield levels.

Jamal *et al.* (2016) study analyzed the growth performance of selected fruit crops and found that the cultivated area under mango, jackfruit, litchi, and pineapple increased significantly due to improved varieties and better management practices. However, banana showed a decline in area, production, and yield because of poor crop management and lack of modern varieties. Mango recorded the highest production growth during 2004–2010, though

its productivity decreased over time due to pest and disease issues. In terms of output change, banana ranked highest, followed by pineapple and jackfruit, while guava showed the least growth. Overall, expansion of cultivated area was the main factor driving output growth for most fruits, whereas yield improvements contributed more to crops like banana, papaya, and pineapple. The study suggested promoting improved varieties and strengthening research and extension services to boost fruit productivity in the Chittagong region.

Mathews (2017) conducted a study examined the economics of pineapple (Ananas comosus L.) cultivation and disposal in Dapoli tahsil of Sindhudurg district, Maharashtra. The findings indicated that the average cost of cultivation per hectare over a three-year period was ₹5,88,220. Among the total expenses, labour costs contributed 42.51 per cent, while the remaining 57.49 per cent comprised material inputs. The analysis further showed that pineapple cultivation was economically viable, generating a net return of ₹9,93,511 per hectare and achieving a benefit–cost ratio of 2.68.

**12.2. Evaluate the magnitude of pre-harvest and post-harvest losses in the selected fruits.**

Sab *et al.* (2017) a study by was carried out in Dharwad and Belgaum districts of North Karnataka during 2013–14 to examine mango production practices and post-harvest conditions. The research used simple random sampling to select 120 farmers from six villages in two taluks and data were gathered through personal interviews. The findings indicated that most respondents had moderate knowledge (72.50%) and adoption (68.33%) of improved mango cultivation practices. Post-harvest losses were estimated at 8.44% at farm level, 4.93% during wholesale and transportation, 5.46% at retail, 3.19% at storageand 6.82% at consumer level, resulting in total losses of 34.49%. Major constraints reported were inadequate post-harvest knowledge, lack of storage facilities, transportation difficultiesand insufficient technical guidance.

Kalyani *et al.* (2018) conducted a study to assess storage losses in different onion varieties, including Bhima Kiran, Bhima Raj, Bhima Red, Bhima Shakti, Bhima Shubra, Bhima Shweta and Bhima Super. The experiment was carried out during the 2013–14 and 2014–15 seasons, where all varieties were cultivated under uniform conditions and stored in a modified structure with bottom and top ventilation at ambient temperature. After four months of storage, the lowest total losses were recorded in Bhima Kiran (26.66 per cent) and Bhima Shakti (35.87 per cent), with no statistically significant difference between these two varieties. In the 2014–15 season, further analysis was conducted on respiration rate and total phenol content of the bulbs. Initially, there was no significant variation in respiration rates among the varieties.

However, total phenol content was found to be highest in Bhima Raj (186.33 mg GAE/100 g), followed by Bhima Kiran, Bhima Shakti, Bhima Shweta and Bhima Shubra, while Bhima Red exhibited the lowest phenol content (35.16 mg GAE/100 g). During storage, both respiration rate and phenol content increased up to 60 days and declined thereafter until 90 days.

Baidya *et al*. (2020) sapota (chikoo) is an important tropical fruit crop in India, valued for its taste and nutritional and medicinal properties. However, its short shelf life leads to significant post-harvest losses. Effective management practices are necessary to maintain fruit quality and extend storage life. Pre-harvest treatments, including the application of growth regulators and nutrients during different growth stages, along with post-harvest techniques such as pre-cooling, chemical treatments, heat treatments, waxing, cold storage, irradiation and modified or controlled atmosphere storage, play a crucial role in reducing losses. Additionally, physiological and biochemical changes during ripening significantly influence fruit quality and storage potential. Overall, adopting appropriate pre- and post-harvest strategies can help enhance the shelf life and marketability of sapota

Iqbal (2020) pre-harvest management practices are vital for enhancing the quality and storage life of fruits like mango, particularly in developing area where such interventions are not widely adopted. Research has demonstrated that the application of plant growth regulators prior to harvest can significantly improve post-harvest performance. For instance, treatments with gibberellic acid ($GA_3$) and salicylic acid (SA) have been found to extend shelf life, reduce physiological weight loss, delay ripening and lower disease incidence. In addition, these treatments contribute to better nutritional quality by increasing levels of ascorbic acid and β-carotene in fruits. Overall, pre-harvest interventions can play a crucial role in maintaining fruit quality and reducing post-harvest losses.

**12.3. Examine the factors influencing pre-harvest and post-harvest losses in the selected fruit crops.**

Gajanana (2002) investigated the marketing system and post-harvest losses of the Poovan variety of banana in Tamil Nadu. The study focused on Tiruchirappalli district, which was selected due to its significant share in banana cultivation area. The findings revealed that banana growers primarily followed two marketing channels. The first involved selling produce in nearby markets through pre-harvest contractors or commission agents, while the second channel consisted of supplying bananas to wholesale agents in distant markets such as Bengaluru, Mumbai and Chennai. The study observed that post-harvest losses were relatively lower in the local marketing channel (approximately 19 per cent) compared to the distant marketing channel (around 21 per cent). The higher losses in the latter were mainly attributed

to damage during long-distance transportation. Additionally, the study suggested that establishing banana processing units in production areas would be economically viable and could help utilize surplus or damaged fruits effectively.

Sreenivasa *et al.* (2002) carried out a study to estimate post-harvest losses in the Banganapalli variety of mango across different stages of the marketing chain. Krishna district was selected for the study due to its leading position in mango area and production within the state. The researchers categorized post-harvest losses into two types: physical losses and economic losses. At the farm level, the average physical loss was estimated at 15.6 per cent, mainly attributed to the harvesting of immature and undersized fruits, which constituted nearly two-thirds of the total losses. In contrast, physical losses at the wholesale market stage were found to be negligible. During ripening and storage, approximately 128 fruits out of 1440 were damaged, accounting for an 8.8 per cent loss. At the retail level, physical losses were recorded at 5.25 per cent. In terms of economic losses, the farm-level loss was estimated at 11.7 per cent, which was lower than the corresponding physical loss. Economic losses varied across fruit sizes, with large, medium and small fruits recording losses of 5.3 per cent, 5.9 per cent and 4.2 per cent, respectively, indicating that fruit size had a greater influence on economic loss than on physical loss. At the retail stage, economic loss was estimated at 4.5 per cent. Overall, the total economic loss from production to consumption was calculated at 21.7 per cent, compared to a total physical loss of 29.7 per cent.

Sudha *et al.* (2005) examined post-harvest management and marketing practices of banana (cv. Tella Chakkara Keli) in the Rajahmundry region. The study revealed that farmers who adopted self-marketing strategies in wholesale or retail markets were able to secure a higher share of the consumer's price, ranging from 64 to 76.2 per cent. Post-harvest losses were evaluated at multiple stages, including farm, market and retail levels. The results showed that marketing efficiency in Channel II was calculated at 1.41. However, when post-harvest losses were accounted for as an additional cost component, the overall marketing cost increased, leading to a decline in marketing efficiency.

**12.4. Analyse the major constraints associated with post-harvest losses.**

Ravikumar (2009) conducted an economic analysis of pomegranate production and marketing in the Chitradurga district of Karnataka. The study found that growers faced several production-related constraints, such as labour shortages during peak periods, limited access to credit and water scarcity. The study found that growers faced several production-related constraints, such as labour shortages during peak periods, limited access to credit and water scarcity. Additional issues included inadequate technical guidance and the unavailability of

quality planting material. On the marketing side, farmers encountered problems like price volatility, high transportation expenses, elevated commission charges, insufficient transport facilities and lack of reliable market information.On the marketing side, farmers encountered problems like price volatility, high transportation expenses, elevated commission charges, insufficient transport facilities and lack of reliable market information.

Dhandhalya and Shiyani (2012) analyzed the economic feasibility of sapota orchards along with the marketing constraints associated with sapota cultivation (Achras sapota L.) in the Saurashtra region. The findings indicated that low market price was the most significant marketing issue encountered by farmers. The study emphasized the necessity of developing an organized cooperative marketing structure for fruit crops in the region. It also recommended promoting fruit-based processing industries to support sapota growers. On the production side, farmers reported challenges such as substantial bird damage and inadequate irrigation facilities.

Koujalagi (2012) carried out an economic evaluation of the production, marketing and export performance of pomegranate in Karnataka. Koujalagi (2012) carried out an economic evaluation of the production, marketing and export performance of pomegranate in Karnataka. The study revealed that every sampled farmers (100%) reported severe incidence of bacterial blight disease as a major production constraint, while a significant proportion (82%) also indicated labour scarcity as a critical issue. In terms of marketing challenges, the majority of growers (97%) expressed lack of adequate price information. Other key problems included insufficient storage facilities, high transportation costs when produce was marketed outside the state, absence of processing facilities, lack of transparency in auction systems and language barriers in out-of-state markets. Other key problems included insufficient storage facilities, high transportation costs when produce was marketed outside the state, absence of processing facilities, lack of transparency in auction systems and language barriers in out-of-state markets. Additionally, high commission charges and the absence of assured marketing were reported by 74% and 55% of the farmers, respectively, along with other constraints affecting marketing efficiency.

Naveen (2013) carried out a study on the economics of banana production and marketing in the Chikkaballapur district of Karnataka. The findings revealed that banana growers encountered several production-related issues, including insufficient irrigation during the summer months, the occurrence of viral diseases, crop damage caused by strong winds and irregular monsoon patterns. The findings revealed that banana growers encountered several production-related issues, including insufficient irrigation during the summer months, the occurrence of viral diseases, crop damage caused by strong winds and irregular monsoon

patterns. On the marketing side, farmers experienced difficulties such as distant markets, fluctuations in prices, inadequate access to market information, more transportation expenses, the involvement of multiple intermediaries and delays in receiving payments after the sale of produce.On the marketing side, farmers experienced difficulties such as distant markets, fluctuations in prices, inadequate access to market information, more transportation expenses, the involvement of multiple intermediaries and delays in receiving payments after the sale of produce.

Tushar (2013) examined the economic feasibility and marketing aspects of sapota orchards in South Gujarat. The study identified key challenges faced by growers, such as a high incidence of diseases, water scarcity, long distances to markets and elevated commission charges. The study identified key challenges faced by growers, such as a high incidence of diseases, water scarcity, long distances to markets and elevated commission charges. It was suggested that adopting recommended agronomic practices and ensuring access to sufficient credit facilities could contribute to expanding the cultivated area and enhancing the productivity of sapota.

Olayinka (2013) analysed the economics of pineapple cultivation in Osun State, Nigeria. The study highlighted several significant constraints affecting pineapple producers, including the unavailability of quality planting material, high perishability of fruits, low market prices, limited access to credit facilities and the prevalence of diseases such as heart rot.The study highlighted several significant constraints affecting pineapple producers, including the unavailability of quality planting material, high perishability of fruits, low market prices, limited access to credit facilities and the prevalence of diseases such as heart rot.

Golappanavar and Patil (2017) conducted an economic analysis of sapota cultivation in the Dharwad district of Northern Karnataka. Their findings indicated that farmers encountered several production-related challenges, including insufficient irrigation facilities, dependence on erratic rainfall, limited access to essential resources, shortage of labour, irregular electricity supply and issues in farm management. Their findings indicated that farmers encountered several production-related challenges, including insufficient irrigation facilities, dependence on erratic rainfall, limited access to essential resources, shortage of labour, irregular electricity supply and issues in farm management. In terms of marketing, the major difficulties reported were inadequate storage facilities, high commission charges, elevated transportation costs, lack of timely and reliable market information, distant marketplaces, low price realization and collusive practices among commission agents and traders. In terms of marketing, the major difficulties reported were inadequate storage facilities, high commission charges, elevated

transportation costs, lack of timely and reliable market information, distant marketplaces, low price realization and collusive practices among commission agents and traders.

Mungalpara *et al.* (2017) examined the production and marketing constraints experienced by banana farmers in Bharuch district of South Gujarat. The researchers collected primary data using a pre-tested interview schedule that included various problems encountered by banana cultivators. Farmers were asked to rank these issues according to their level of importance and the responses were analyzed using the Garrett ranking technique. Farmers were asked to rank these issues according to their level of importance and the responses were analyzed using the Garrett ranking technique. The findings revealed that price fluctuation of banana in the market was perceived by growers as the most significant constraint affecting production. In terms of marketing challenges, inadequate transportation facilities emerged as the most serious problem. Other important constraints reported by the farmers included high marketing expenses, limited access to market finance, lack of proper storage facilities, absence of grading practices, low market prices, insufficient market information and delays in payment. Other important constraints reported by the farmers included high marketing expenses, limited access to market finance, lack of proper storage facilities, absence of grading practices, low market prices, insufficient market information and delays in payment. These issues were found to adversely affect both the marketing efficiency and profitability of banana growers in the region.

Kumar *et al.* (2020), according to the study conducted by India has emerged as one of the leading producers of horticultural crops due to continuous technological progress, research developments and supportive policy measures. The country ranks second globally in the production of fruits and vegetables, contributing around 13.6 per cent of total fruit production and approximately 14 per cent of global vegetable output. Owing to its diverse climatic conditions and varied physiographic features, India supports the cultivation of a wide range of horticultural commodities including fruits, vegetables, spices, nuts, flowers and plantation crops such as cocoa, cashew nut and coconut. Data reported by the National Horticulture Board for the year 2016–17 indicates that the country produced nearly 92.8 million tonnes of fruits from about 6.40 million hectares and 175 million tonnes of vegetables from around 10.30 million hectares of cultivated land. In Chhattisgarh, major fruit crops include mango, guava, lime, litchi, cashew nut and sapota, while several minor fruits such as custard apple, bael, ber and aonla are also grown either under cultivation or in the wild. The total area under fruit cultivation in the state was reported to be approximately 261,512 hectares, producing about 2.59 million tonnes of fruits during 2017–18. Fruit production accounts for nearly 25.27 per

cent of the total horticultural output of the state. Among the various fruits grown in the region, mango occupies the largest area, followed by banana, papaya and guava in terms of cultivation and production. Among the various fruits grown in the region, mango occupies the largest area, followed by banana, papaya and guava in terms of cultivation and production.

**12.5. Propose appropriate strategies and interventions aimed at reducing pre-harvest and post-harvest losses in fruit production**

Ashok and Maheswari (2008) investigated the entrepreneurial behavior and adoption patterns among banana growers in the Gulbarga district of North Karnataka. The results revealed that labour shortages, unreliable electricity supply and inadequate storage facilities were the primary constraints reported by farmers. Additionally, more than half of the respondents expressed a strong need for training in areas such as disease management and marketing practices.

Kathirvel (2008) examined the economic constraints affecting banana production using the Garrett Ranking Technique. The study identified inadequate access to credit as the critical constraint faced by farmers, followed by the high cost of fertilizers. In contrast, issues such as small landholdings and lack of technical guidance were considered relatively less significant.

Muthupandi (2009) analyzed the production challenges encountered by banana growers and found that strong winds were the most severe problem, followed by disease incidence and excessive rainfall. Soil-related issues were ranked as a comparatively less serious constraint.

Geetha and Meena (2010) applied factor analysis to identify key issues in banana production. Their findings indicated that financial constraints, environmental risks, natural farming conditions, personal risks and spoilage-related factors were the major determinants affecting production.

**13. Materials and Methods:**

**13.1 Location**

**13.2 Sampling techniques**

**13.3 Year and source of data**

**13.1 Location**

This research is proposed to be conducted in Saurashtra region of Gujarat, with a specific emphasis on fruit cultivation. Among the various horticultural crops grown in this region, mango and chiku (sapota) have been specifically selected due to their extensive cultivation and economic significance. The Gir Somnath and Junagadh districts have been chosen as the primary areas for this study, as they serve as major production hubs for these selected fruit crops within Saurashtra.

## 13.2 Sampling techniques

To collect data, a simple random sampling method will be adopted to ensure fairness in selection and unbiased representation of the respondents. Farmers cultivating mango and chiku in the selected districts will be included in the sampling frame. From this population, a total of 200 respondents will be selected, comprising 100 farmers for each crop. Although the sampling will be conducted within the selected districts, the respondents are considered representative of the broader Saurashtra region, given the uniformity of agro-climatic conditions and cultivation practices across the area.

The purpose of this study is to evaluate both the pre-harvest and post-harvest management practices associated with the cultivation of mango and chiku. Pre-harvest aspects encompass land preparation, input utilization, irrigation, pest and disease management and harvesting methods. Post-harvest management focuses on yield handling, grading, storage, transportation and marketing. By examining these dimensions, the study aims to identify existing practices, the constraints faced by farmers and potential areas for improvement within the fruit supply chain.

The findings of this research are expected to yield valuable insights into the efficiency of current management practices and contribute to the development of strategies aimed at minimizing post-harvest losses, enhancing productivity and improving farmers' incomes in the Saurashtra region.

The sample for study will be selected based on the importance and distribution of fruit cultivation in the Saurashtra–Kutch region of Gujarat during 2024–25. The region contributes significantly to the state’s fruit output, covering about 95,165 hectares with production exceeding 1.02 million metric tons. Noticeable variations in area, production and productivity across districts make it suitable for detailed analysis. The study focused on mango and chikoo due to their economic significance. Junagadh and Gir Somnath districts will be chosen as they have the highest concentration and production of these crops. Favourable agro-climatic conditions and the popularity of the Kesar mango variety support high cultivation levels, while suitable soil and market access promote chikoo production. Farmers from these districts will be selected using simple random sampling, ensuring a representative sample and improving the accuracy and reliability of the study outcomes.

**Table 12.1: Details of sample selection of zone-wise and district-wise estimated area, production and productivity of fruits in Gujarat (2024–25)**

(Area in ha, Production in MT, Productivity in MT/ha)

| Zone | District | Area (ha) | Production (MT) | Productivity (MT/ha) |
|---|---|---|---|---|
| Saurashtra–Kutch | Surendranagar | 8,074 | 75,433 | 9.34 |
| | Rajkot | 2,375 | 30,012 | 12.64 |
| | Jamnagar | 1,212 | 15,199 | 12.54 |
| | Porbandar | 1,081 | 10,043 | 9.29 |
| | Junagadh | 16,450 | 178,951 | 10.88 |
| | Amreli | 9,966 | 90,026 | 9.03 |
| | Bhavnagar | 21,234 | 281,543 | 13.26 |
| | Morbi | 9,083 | 122,630 | 13.50 |
| | Botad | 2,684 | 41,223 | 15.36 |
| | Gir Somnath | 22,156 | 170,542 | 7.70 |
| | Devbhumi Dwarka | 850 | 10,475 | 12.32 |
| | Saurashtra–Kutch Total | 95,165 | 1,026,077 | 10.78 |
| | State Total (Gujarat) | 444,125 (ha.) | 8,581,591 (MT) | 19.32 (MT/ha) |

*(Directorate of Horticulture, Government of Gujarat, 2025)*

**Table 12.2 Details of sample selection of zone-wise and district-wise estimated area, production and productivity of fruits in Gujarat (2024–25)**

(Area in ha, Production in MT, Productivity in MT/ha)

| | Mango | | | Sapota | | |
|---|---|---|---|---|---|---|
| **District** | **Area** | **Production** | **Productivity** | **Area** | **Production** | **Productivity** |
| Junagadh | 9530 | 64245 | 6.76 | 3660 | 36050 | 9.85 |
| Gir Somnath | 19183 | 128736 | 6.71 | 1255 | 11492 | 9.16 |
| Surendranagar | 213 | 1024 | 4.81 | 68 | 315 | 4.63 |
| Rajkot | 136 | 1034 | 7.60 | 141 | 1612 | 11.43 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Jamnagar | 512 | 3846 | 7.51 | 75 | 877 | 11.69 |
| Porbandar | 552 | 4185 | 7.58 | 153 | 1459 | 9.54 |
| Amreli | 8243 | 67261 | 8.16 | 324 | 2533 | 7.82 |
| Bhavnagar | 5580 | 43206 | 7.74 | 1362 | 14159 | 10.40 |
| Morbi | 140 | 930 | 6.64 | 100 | 978 | 9.78 |
| Botad | 14 | 82 | 5.86 | 7 | 63 | 9.00 |
| Devbhumi Dwarka | 150 | 989 | 6.59 | 132 | 1491 | 11.30 |
| Saurashtra–Kutch Total | 44233 | 315538 | 7.13 | 7277 | 71029 | 9.76 |

*(Directorate of Horticulture, Government of Gujarat, 2025)*

**13.3. Year and source of data**

Relevant data for the study will be gathered from both primary and secondary sources.

**13.3.1. Primary Data:**

Primary data will be obtained from selected farmers through personal interviews, utilising a well-designed and pre-tested questionnaire. The collected data will encompass various aspects, such as demographic characteristics (age, education and family size), details regarding landholdings, the area under fruit cultivation, labour utilisation, input usage, total production and selling prices. Additionally, information will be gathered regarding harvesting methods, packaging techniques, storage facilities, modes of transportation and the extent of losses incurred during various post-harvest stages including harvesting, storage, transportation and weather-related factors.

**13.3.2. Secondary Data:**

Secondary information data will be sourced various published materials from the official records of government departments and relevant websites including district-level offices.

**13.3.3 Socio-economic characteristics**

The socio-economic profile will encompass specific and essential variables related to farmers, as well as pre- and post-harvest losses, thereby rendering this study more detailed, informative and beneficial for the farmers (Kumar, 2020).

**14. Statistical Analytical**

Keeping in view the objective formulated for the study, the method of analysis are presented under the following heads:

### 14.1 Cost and returns analysis

Cost concept will be used for the estimation of the cost of cultivation of fruit crops by following the cost concept (Kumar 2020).

#### 14.1.1 Cost Concept

To ensure uniformity and comparability, the standard cost of concepts will be used as followed measurement and valuation of different

Cost A1

Below:

- Hired human labour
- Bullock labour and Machine labour
- Seed
- Manures and Fertilisers
- Plant protection
- Irrigation charges
- Depreciation and repairing charges
- Interest expenses on short-term capital
- Miscellaneous expenses
- Cost A2 is obtained by adding rent paid for leased-in land to Cost A1.
- Cost B1 is calculated by adding interest on owned fixed capital (excluding land) to Cost A1.
- Cost B2 is derived by adding the rental value of owned land and rent paid for leased-in land to Cost B1.
- Cost C1 is computed by adding the imputed value of family labour to Cost B1.
- Cost C2 is obtained by adding the imputed value of family labour to Cost B2.
- Cost C3 is calculated by adding 10 per cent of Cost C2 as management cost to Cost C2.
- **14.2.2 Returns from fruit crops**

Gross Income = Total Quantity of chilli Produced × Market Price

Net Return = Gross Income - Cost of Cultivation

$$\text{Cost of Production} = \frac{\text{Total cost of cultivation}}{\text{Total output}} \quad \ldots (1)$$

Benefit-cost ratio:

The benefit–cost ratio represents the relationship between the value of total output and the cost of cultivation under different cost concepts. Evaluating the profitability of crop production is

incomplete without estimating this ratio, as it indicates the returns generated per unit of investment. It is computed by dividing the gross income by the total cost incurred in cultivation. In this study, the benefit–cost ratio will be estimated at various cost levels, namely Cost A1, Cost A2, Cost B1, Cost B2, Cost C1, Cost C2, and Cost C3.

Benefit–Cost Ratio = Gross Income / Total Cost of Cultivation

### 14.3. Estimation of Pre-Harvest Losses

To examine the factors contributing to pre-harvest losses among fruit growers, a 'Multiple Linear Regression' approach will employed. The selection of the model, as well as the explanatory variables, will be guided by both theoretical considerations and practical relevance.

Pre-harvest losses will be estimated based on:

- Field-level observations
- Farmer responses

**Factors affecting pre-harvest losses**

**Specification of the Regression Model**

To examine the factors influencing post-harvest losses of fruit crops on the selected farms in the study area, a linear form of the multiple regression model will be applied to the collected data. The functional relationship between the dependent and independent variables is expressed as follows:

$$Y = a + b_1X_1 + b_2X_2 + b_3X_3 + \ldots + b_{11}X_{11} + U \quad \ldots (2)$$

Where:

Depended variable

- Y = Pre-harvest losses (%)

Independent variable

- $X_1$ = Experience in fruit cultivation (Year)
- $X_2$ = Education of head of family (Illiterate = 0, Primary = 1, Secondary = 2, Higher Secondary = 3, Graduate and above = 4)
- $X_3$ = Area under fruit crop (Hectares)
- $X_4$ = Timely use of pesticides (Yes=1, No=0)
- $X_5$ = Incidence of pests and diseases (Low=1, Medium=2, High=3)

- $X_6$ = Environmental conditions during the crop season (Favourable=1, Moderate=2, Unfavourable=3)
- $X_7$ = Labour availability during the crop period (Adequate=1, Moderate=2, Inadequate=3)
- $X_8$ = Access to extension services (Yes=1, No=0)
- $X_9$= Irrigation availability (Yes=1, No=0)
- $X_{10}$= Expected Yield (Quintals per hectare)
- $X_{11}$= Actual Yield obtained (Quintals per hectare)
- a = Intercept (constant term)
- $b_1$ to $b_{11}$ = Regression coefficients indicating the influence of respective variables
- U = Error term Disturbance term representing unobserved factors

All ordinal variables will be treated as continuous for the purpose of regression analysis.

**14.4 Estimation of post-harvest losses**

**Factors affecting post-harvest losses of fruit:**

Selection of variables will carried out following the approach adopted by Rathod (2022)

**Multiple Linear Regression Analysis**

$$Y = a + b_1 X_1 + b_2 X_2 + b_3 X_3 + ... + bn\, Xn + e \quad \ldots (3)$$

Where:

Dependent variable

- Y = Post-harvest losses (%)
- Income Loss (quintal or per hectare)

Independent variables

- $X_1$ = Age (year)
- $X_2$ = Education of the head of family (Illiterate = 0, Primary = 1, Secondary = 2, Higher Secondary = 3, Graduate and above = 4)
- $X_3$ = Experience of farmer (Years)
- $X_4$ = Size of land holding (Small=1, Medium=2, Large=3)
- $X_5$ = Family Labour availability (Adequate=1, Moderate=2, Inadequate=3)
- $X_6$ = Ripening problem (Not at All =0, Low =1, Medium=2, High=3)
- $X_7$ = Hired Labour availability during harvesting (Easily =1, Available with Difficulty=2, Not Available=3)
- $X_8$= Transportation facilities (Good=1, Average=2, Poor=3)

- $X_9$= Distance to market ((KM)
- $X_{10}$= Use of improved technology (Not Using=0, Partial=1, Full adoption=2)
- $X_{11}$= Storage facility available (Yes=1, No=0)
- $X_{12}$= Access to market information (Yes=1, No=0)
- $X_{13}$= Type of packaging used
- a = Intercept (constant term)
- $b_1$….b*n* = Regression coefficients indicating the magnitude and direction of influence of each independent variable on post-harvest losses
- *e* = Error term, capturing Influence of omitted variables and random disturbances

**14.5 Constraints Analysis**

Difficulties experienced by the fruit growers, wholesalers and retailers of fruit during pre and post-harvest management will be identified. Production and marketing constraints of fruit growers will be achieved by the frequency and per centile method. The extent of constraints faced by fruit farmers will be measured using a three-point continuum scale.

Each respondent will be asked to indicate the severity of each constraint as:

- Severe constraint - Score 3
- Moderate constraint - Score 2
- Less severe constraint - Score 1

The total score for each constraint will be obtained by summing the scores of all respondents.

The mean score technique will use for the calculate of Constrain in fruits growing.

$$\text{Mean Score} = \frac{\text{Total score obtained for a constraint}}{\text{Total number of respondents}} \quad \ldots (4)$$

The constraints will be ranked based on their mean scores, with higher mean values representing more severe constraints (Kumar 2020).

- Frequency method
- Percentage

**14.6 Garrett ranking technique**

The Garrett ranking method will be applied to assess the constraints experienced by fruit growers. Under this approach, respondents will be requested to rank the identified problems based on their severity. The ranks assigned by the farmers will then be transformed into numerical scores using the following formula:

$$Percent\ Position = \frac{100(R_{ij}-0.5)}{N_j} \quad \ldots (5)$$

Where,

$R_{ij}$ = Rank assigned to the $i^{th}$ factor by the $j^{th}$ respondent.

$N_j$ = Total number of factors ranked by the $j^{th}$ respondent.

In per cent positions will then be converted into Garrett scores using Garrett's conversion table. The mean Garrett score for each parameter will be calculated and parameters will be ranked based on the highest mean score, indicating the most severe constraint.